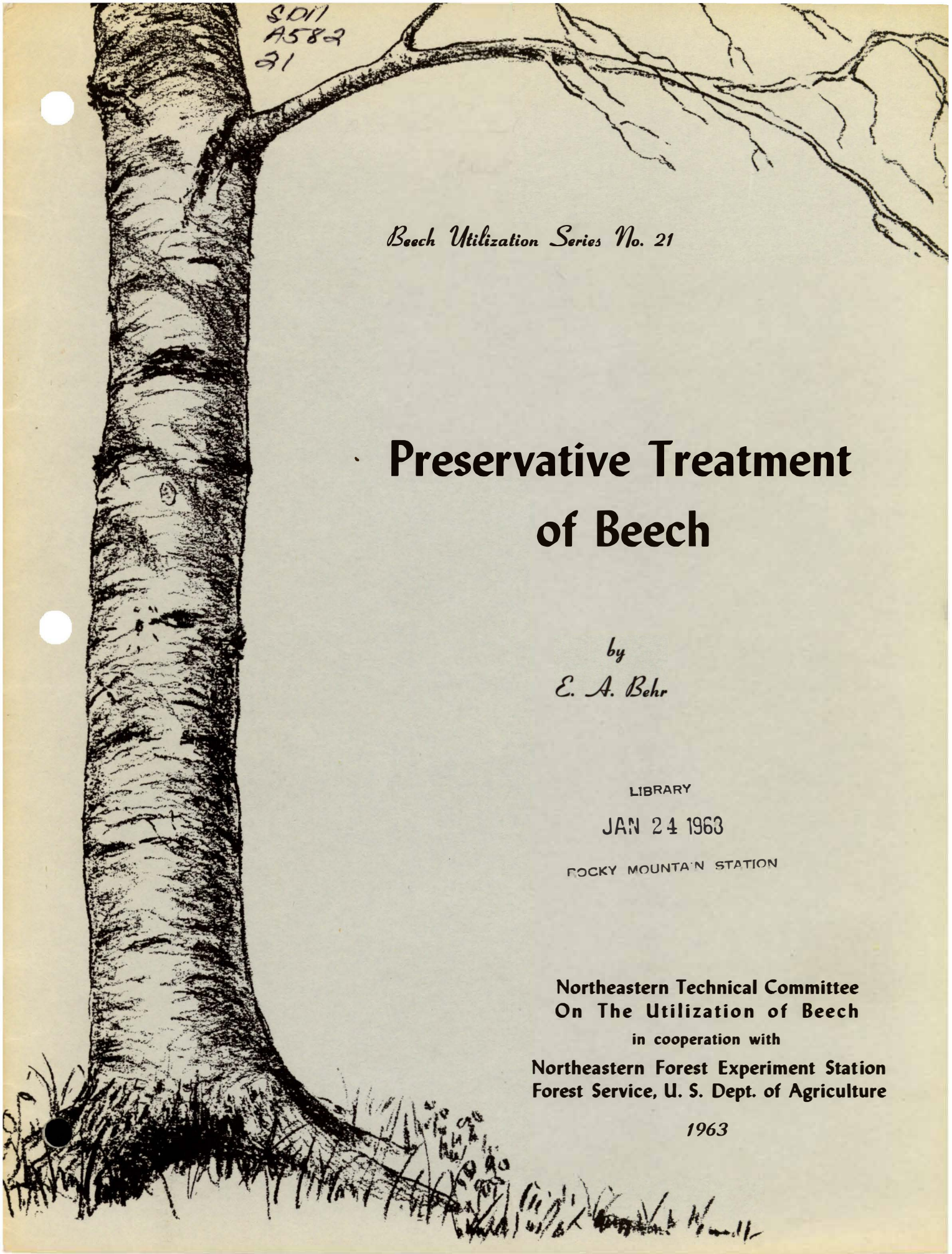

Beech Utilization Series No. 21

Preservative Treatment of Beech

by

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Northeastern Technical Committee
On The Utilization of Beech
in cooperation with
Northeastern Forest Experiment Station
Forest Service, U. S. Dept. of Agriculture

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FOREWORD

The wood of the American beech tree (*Fagus grandifolia* Ehrh.) is well suited for a large number of uses, and it is rather widely used by manufacturers. Yet the amount used is not in proportion to the amount that grows in our northeastern forests. The utilization of beech — both in the woods and in the factory —has been recognized as a problem.

One reason for this is in the nature of the wood: it has a reputation for being difficult to season. Another is that many of the beech trees in our forests are of poor quality. And there are some plain prejudices against beech.

Research is finding ways to utilize beech as efficiently as any of the other comparable hardwoods can be handled. Considerable information about beech has been gathered. Yet most of this information, until recently, was available only in fragmentary form in scattered technical reports. Some of it has yet to be published.

To study the problems of putting beech to the uses it deserves, and to promote the better management of the forests in which it grows, a Northeastern Technical Committee on the Utilization of Beech was organized in 1949. This committee, which included representatives of federal and state forestry agencies, universities, and state experiment stations, decided to assemble and publish the available information about the utilization of American beech.

As its part of this cooperative project, the Northeastern Forest Experiment Station has undertaken to edit, publish, and distribute this series of 21 reports. This report is the last in the series. The reports previously published are:

1. Some physical and mechanical properties of American beech.
2. Storage of beech logs and bolts in the Northeast.
3. The steam-bending of beech.
4. The chemistry and chemical utilization of beech.
5. Gluing techniques for beech.
6. Beech for veneer and plywood.
7. Beech for containers.
8. Beech for flooring.
9. The machining of beech.
10. Logging beech.
11. Seasoning beech lumber.

(CONTINUED ON INSIDE OF BACK COVER)

Preservative Treatment of Beech

by

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INTRODUCTION

THERE is little doubt that beech lumber decays or that it needs the addition of a preservative if it is to be used in contact with soil or in other exposed situations. The heartwood is classed as slightly decay-resistant or nonresistant (*21*). The sapwood, as is common with all species, decays readily under conditions of favorable moisture and temperature. These conditions are in the same range as those for other hardwoods and for this reason they are not given here.

A considerable group of wood-rotting fungi has been found to decay beech. Some of these are listed by Humphrey (*12*) and Boyce (*4*) as follows: *Fomes fomentarius, Hypoxylon cohaerens, Hypoxylon coccineum, Hydnum erinaceum, Hypocrea citrina, Exidia glandulosa,* and *Pholiota adiposa.* These fungi have all been found on beech either in storage or in use where no preservative was present. As far as can be determined, there is nothing in the literature on decay

fungi isolated from beech that had been given a preservative treatment. No doubt there are other wood-rotting fungi capable of attacking beech besides the group just mentioned.

A large number of service records for beech crossties are given in the Beech Utilization Series report by Wyman (*23*). Data were assembled from records of the Baltimore and Ohio Railroad; the Chicago, Burlington and Quincy Railroad, and the Chicago and Eastern Illinois Railroad.

First, to corroborate the durability of beech, a study was made of the average life of untreated beech crossties in comparison with other species (table 1). These values were based on the 32nd annual inspection of the Chicago, Burlington and Quincy Railroad test tracks (*6*), which are located in the Midwestern and Great Plains States.

Table 1.—*Average life of untreated ties*

Species	Average life
	Years
Ash	5.1
Beech	5.0
Red Birch	3.6
White Elm	5.3
Hickory	5.5
Hard Maple	4.7
Red Gum	4.1

The tests included in table 1 showed that beech ties treated with creosote had an average life of 26.9 to 31.5 years; treated with 60/40 creosote petroleum they had a life of 21.9 years, and treated with zinc chloride, 15.8 to 16 years. However, it should be stressed that these tests were not closely controlled. Retentions may have been higher than for ties customarily used by the railroad. Likewise, tests (*8*) of sawed beech treated by the Santa Fe Railroad and inserted in test tracks in Illinois, Kansas, Missouri, and Texas showed average lives of 16.5 to 27.8 years. All these records indicated that beech crossties can be treated to give reasonably long life.

Other items of beech that have been treated and exposed in test areas are scarce. Table 2 lists these service records from various sources (*14, 3*).

Schulz (*19*) reports that beech crossties in Germany last about 3 years if untreated, while those treated with creosote last 40 years. Nearly all of the crossties now being purchased for the German State Railways are European beech, which has properties very much like American beech.

Table 2.—*Service tests on American beech*

Item	Test laboratory	Preservative	Method of impregnation	Retention	Average life
				lb./cu. ft.	*Years*
Wharf posts	Prince Edward Is.	Creosote	Vapor process	—	8
Wharf posts[1]	Prince Edward Is.	—	—	—	4
Wharf flooring	New Brunswick	Creosote	—	—	11.4-20.5
Fence posts	Maryland	Creosote	Hot-cold bath	8.5	48
Fence posts	Maryland	Creosote	Hot-cold bath, butts only	—	13

[1]The only treatment in this test was a heat application.

APPLICATION OF PRESERVATIVES

Pressure

As with other hardwoods, the deepest penetration and greatest retentions in beech are obtained by forcing the preservative into the wood under pressure. It has been known for a long time that beech sapwood is easy to impregnate by pressure, but heartwood may or may not be. The white heartwood, for instance, is classed by Teesdale and MacLean as easy to treat (*20*), but the red heartwood is very difficult to treat. This difference is attributed to the presence of tyloses that obstruct the red heartwood vessels. Unfortunately, no way is known to remove these tyloses in order to improve penetration.

Pressure-treating plants in the eastern United States and Canada were contacted by letter in 1962 to determine the various treating schedules used on beech. The schedules obtained are shown in table 3. Some of these plants reported that they normally do not segregate beech for treatment but include it with other northern hardwoods such as birch and maple.

Penetrations reported in the heartwood, even with incising, were disappointing to some observers. In view of previous statements about relative penetrability of red and white heartwood, it should be noted that apparently much of the beech found is the red heartwood type. Two plants reported zero to 1/8-inch side penetration and 2-inch end penetration in the heartwood. Another plant that treated crossties found an average side penetration of 1/2 inch. These crossties were well seasoned when treated and had about 20 percent moisture content. The plant that treated pole line material found 80 percent penetration of heartwood. Although the size of the wood items was not given, the thickness was probably much less than for ties; and this may account for the greater percentage of penetration.

Table 3.—*Schedules used for pressure treatment of American beech*

Item	Incised	Initial air pressure	Preservative pressure		Preservative temperature	Vacuum		Type of preservative	Retention
		P.s.i.	*P.s.i.*	*Hrs.*	*°F.*	*Hg.in.*	*Hrs.*		*lb./cu.ft.*
Pole line material[1]	No	—	100	0.5	—	24	—	A	14
6-by 6 inch culvert stock	Yes	30	170	3	175	25	—	B	8
Crossties[2]	Yes	20	200	4.5	200	23	1	C	8
Crossties	Yes	30	175	5.5	195	22	1.25	C	6.5
Crossties	Yes	—	175	2	210	26	1	D	7.5

[1]Preheated in preservative at 230° F.
[2]Pressure applied for 5 minutes.
Abbreviations:
P.s.i. = pounds per square inch.
Hg. in. = inches of mercury.

Type of preservative
A = Pentachlorophenol, 5% in oil.
B = Creosote.
C = 50% coal tar creosote; 50% petroleum oil.
D = Creosote and coal tar creosote.

All but one of the reporting plants incise beech before pressure treatment. Incising of hardwood ties, including American beech, has been discussed at length by Rand (*16*). In spite of the reported advantages of incising beech, Rand stated that his firm did not use beech crossties because most were impenetrable heartwood. Schulz (*19*) reports that European beech grown in Germany also is commonly found with red heart that is almost impossible to impregnate. On the other hand, European beech that grows in England apparently does not develop red heart.

However, incising European beech has improved the results of treatment in many instances, according to Franciosa (*7*). The wood structures of European and American beeches are so much alike that each species should behave about the same under pressure treatment. A double successive Rueping treatment, which is commonly used in Europe, was used on these ties.

It was found that there was not a great deal of difference in penetration and distribution of creosote in unincised or incised beech when cut immediately after the Rueping treatment. However, after 3 months of storage the preservative in the incised ties was better distributed. Bleeding or drip was also stopped by incising.

Harkom (*9*) has described the pressure treatment of mixtures of beech, birch, and maple ties. His investigations led to the conclusion that maple and beech can be treated together but birch and beech cannot. Birch absorbs preservative faster than beech and robs it of preservative. In these tests all ties were incised; however, no mention was made of the proportion of sap-

wood and heartwood. Harkom also concluded that incising did not increase the penetration or absorption in beech.

In these tests initial air pressure of 50 pounds per square inch was held for 30 minutes and then a 70/30 creosote/coal tar solution was applied for 2-1/4 hours at 172 pounds per square inch pressure. The preservative temperature was 190° F. Increasing pressure periods from 2-1/3 hours to 5 hours did not greatly increase retention or penetration. With these conditions, retentions were 4.8 to 5.8 pounds per cubic foot and side penetration was 0.24 to 0.58 inches.

A study was made by Gustin[1] on dry beech to determine what moisture content between 8 and 25 percent led to the best penetration and maximum absorption for a particular Lowry schedule. The heartwood had practically no penetration, and all sapwood was penetrated regardless of the moisture content. Statistical tests of the retentions showed that the author's conclusions needed revision. Absorptions at 8.6 percent moisture content were not significantly different from those at 15.6 percent. However, at 20.5 percent less creosote was absorbed than at lower moisture contents. It was also verified by Bishop[2] that penetration and absorption fall off as the moisture content increases. Because different amounts of heartwood were used in specimens for the Bishop test, conclusions were uncertain as to the effect of higher moisture content on results of treatment. According to later tests by Huffman (*11*) of kiln-dried beech ties, good absorption and penetrations were obtained at 42.6 percent average moisture content.

The magnitude of initial air pressure and its duration have also been studied by Thomas[3], using the Rueping process to treat beech. It was found useless to hold the initial air pressure for more than a few minutes. At air pressures above 50 pounds per square inch, incomplete sapwood penetration was obtained. Below 50 pounds per square inch initial air pressure, sapwood was completely penetrated. Table 4 shows the effect of varying the initial air pressure on the retention of creosote when a preservative pressure of 175 pounds per square inch was held for 1-1/2 hours.

In Europe, where beech is a much more important species than in the United States, patents have been granted covering specialized pressure treatment of European beech (*13*) (*18*). Each patent takes an opposite view. One specifies,

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[1]Gustin, Harold E. Effect of moisture content upon absorption and penetration of creosote in beech at moisture contents ranging from 25 to 8 percent. Masters thesis, New York State College of Forestry, 1932.

[2]Bishop, A. H. Effect of moisture percent on absorption and penetration of creosote in beech. Masters thesis, New York State College of Forestry, 1931.

[3]Thomas, Donald R. Effect of preliminary air pressure on absorption and penetration of coal tar creosote. Masters thesis, New York State College of Forestry, 1931.

for instance, treatment by a pressure schedule followed by heating in preservative at 100° C. without pressure, presumably like the typical expansion bath in use in North America. The other covers heating beech at 100° C. in a preservative bath for several hours before treating by a pressure schedule.

Table 4.—*Retention of creosote by 4" x 4" x 5' beech of 18 percent moisture content at various initial air pressures held for 15 minutes. Preservative pressure of 175 p.s.i. held for 1½ hours.*

Initial air pressure	Retention of preservative
lb./sq. in.	*lb./cu. ft.*
25	7.5
50	4.25
75	4.15
100	2.15
125	2.35

In North America, creosote, creosote in mixture with petroleum or coal tar, and pentachlorophenol in oil are used for treatment of beech. Also, there may be various water-borne preservatives used for mine timbers: at least these preservatives are included in highway department specifications.

Boultonizing

Boiling under vacuum — Boultonizing — is sometimes resorted to in the treatment of green wood. In this process, some of the water is removed and the wood is raised in temperature at greater depths than is usual in pressure treating without preheating. Harkom describes how three charges of beech ties were Boultonized for 3, 6, or 6-1/2 hours under a 16-inch vacuum at 180° F. and subjected to a typical Rueping treatment (*10*). The results showed that penetrations and retentions were about as good as those obtained with air-seasoned ties.

When unseasoned beech ties were heated in 70/30 creosote/coal tar solution for 6 hours at 200° F. without vacuum but prior to pressure treating, penetration was a little better than when comparable ties were Boultonized. However, retention was equal.

In spite of the apparent value of these preheating treatments on green beech, the ties checked badly after treatment and exposed untreated heartwood. Consequently, the operation was not entirely successful.

Non-Pressure

Since much of the heartwood of beech is difficult to treat under pressure, non-pressure methods would be even less likely to be effective. On the other hand, the sapwood is more permeable and can be treated by certain non-pressure methods. Because very little information is available on non-pressure treatment of American beech, information is included only on European beech. However, it cannot be guaranteed that one treats the same as the other by non-pressure methods.

Treatment of Unseasoned Wood

Beech can be treated by debarking freshly cut logs in the center and applying water-borne preservatives to each end according to a method patented by Wolman (*22*). As yet, this method is not used commercially. Another report by Milovanovic (*15*) tells how a preservative made of copper sulfate was introduced into holes drilled into the butts of standing trees; zinc chloride was then applied after the copper sulfate.

Other methods of treatment of unseasoned wood such as double diffusion, butt soaking (Clemson College method), steeping, and Osmose have not been used on beech. At least, there are no published reports on service tests of beech posts so treated. The tire-tube method, which is similar to these, has been used; therefore it is quite possible the other methods might also be adaptable.

Cold-Soaking

Blew describes (*2*) reasonably good penetrations of round, seasoned beech posts by soaking in pentachlorophenol-oil solution. Soaking times of 6, 24, 48, and 168 hours were used, which gave retentions of 3.2, 4.8, 5.8, and 8.0 pounds of preservative per cubic foot respectively. Side penetration at the ground line ranged from 0.19 to 0.35 inches, although the sapwood on these posts was 1.34 to 1.75 inches thick. Accordingly, only a small portion of the sapwood was protected by this method of post treating.

Cold soaking of 1 x 2 x 15-inch beech fence pickets with 4 percent pentachlorophenol in mineral spirits resulted in a retention of 4 pounds of preservative solution per cubic foot after 64 hours, the maximum time used in this test. In this test a retention of 3 pounds was reached in about 10 hours of soaking. When a copper naphthenate solution (containing 2 percent copper) in mineral spirits was used, a retention of 3.52 pounds per cubic foot was reached after 85 hours.

European beech has been reported by Bryan and Redding (*5*) as easy to treat. This would seem to refer to white heartwood because red heartwood has been reported elsewhere as very resistant and hard to treat (7).

Again, the only published report on the soak treatment using water-borne salts is on European beech (*1*). Air-dry and green European beech sapwood and heartwood were soaked in a silicofluoride or a bifluoride solution for 8- and 24-hour periods. Compared with soaking in oil-type preservatives, the volume absorbed from the salt solutions was less. The salts penetrated more deeply than the oils: 1 to 10 mm. for the salts compared with 0.1 to 1 mm. for the oils. And as anticipated, the depth of penetration of the salts increased with wood moisture content due to the mechanism of treating-diffusion.

Hot and Cold (Thermal)

One report of thermal treatment of 1 x 2 x 15-inch fence pickets of American beech was available.[4] The following schedule was used: The copper abietate solution (in gas-oil) was heated to 150° F. for a period of 1/2 hour; then the American beech pickets were immersed in the solution at 165° F. and held there for 2 hours. The pickets were next allowed to cool to room temperature while submerged in the solution; this process took 16 hours. The final step was a 1/2 hour steaming at 212° F. to remove residue. The final retention of solution was 7.5 pound per cubic foot.

Brushing and Spraying

Bavendamm and Seehann mention brush application of preservative to European beech in their publication (*1*). Judging from the results of other methods of treating beech, one is safe in assuming that limited retention would result with this method — especially if heartwood is to be treated. Certainly beech treated in this way would be suitable only when the decay hazard was low.

Specifications for Treatment

Preservative treatment of beech for crossties and switchties is covered in American Wood Preservers Association Standard C6-60: beech, birches, and maples are limited as to their adaptability to a pressure treating schedule

[4]Communication from Canadian Forest Products Laboratory, Ottawa.

according to the standard. Incising is recommended. A maximum treating pressure of 200 pounds per square inch is imposed. The minimum retention is 7 pounds per cubic foot of preservative, either creosote or creosote mixed with coal tar or petroleum. No requirement is placed on heartwood penetration, but 85 percent of the sapwood must be treated. This is the only standard of the A.W.P.A. for preservative treatment that includes beech.

The American Railway Engineering Association includes beech in their specifications for crossties and switch ties. Preservative treatment of the ties by pressure methods is covered in a separate specification of this association.

Though beech is not specifically mentioned in the specifications of the American Association of State Highway Officials, it is allowed for use as posts and, presumably, for cattle guards. Pentachlorophenol, copper naphthenate, and seven water-borne preservatives are listed along with required retentions for uses as posts and lumber to be used above ground or in ground contact.

Beech posts, round or sawed, pressure-treated with preservatives, are included in Michigan Highway Department Specifications. Treated sheet piling can also be beech, among other species, in these specifications.

If one is looking for markets for treated beech, the specifications of other state highway departments should also be reviewed. And even though present specifications of a state highway department may not allow beech, future revisions may include it — especially if beech producers convey their interests and concerns to officials in charge of such specifications.

Federal Specifications TT-W-571 and MM-T-371b cover treatment of many types of wood, including beech cross and switch ties.

LITERATURE CITED

(1) Bavendamm, W., and G. Seehann.
1960. WOOD PROTECTION TECHNIQUES —REPORT 9. INVESTIGATIONS IN CONDITIONS SIMILAR TO PRACTICE ON THE PRESERVATION OF BEECH TIMBER BY BRUSHING AND BY SOAKING. Holzforschung und Holzverwertung 12: 50-54.

(2) Blew, J. O.
1961. TREATING WOOD BY THE COLD-SOAKING METHOD. U.S. Forest Prod. Lab. Rpt. 1445, 22 pp., illus.

(3) Blew, J. O., and John W. Kulp.
1959. SERVICE RECORDS ON TREATED AND UNTREATED FENCE POSTS. U.S. Forest Prod. Lab. Rpt. 2005, 49 pp.

(4) Boyce, J. S.

1961. FOREST PATHOLOGY. 572 pp., illus. McGraw-Hill Book Co., New York, N.Y.

(5) Bryan, J.
1946. METHODS OF APPLYING WOOD PRESERVATIVES, PART 1. NON-PRESSURE METHODS. Dept. Sci. and Indust. Res., Forest Prod. Res. Records 9. 13 pp., illus. London, England.

(6) Burton, W. J.
1943. REPORT OF COMMITTEE 7-1, TIE SERVICE RECORDS. Amer. Wood Preservers Assoc. Proc. 39: 92-100.

(7) Franciosa, G. F.
1956. EFFECT OF INCISING BEECH CROSSTIES. Forest Prod. Jour. 6: 264-270.

(8) Goodwin, W. R.
1947. REPORT OF COMMITTEE 7-1, TIE SERVICE RECORDS. Amer. Wood Preservers Assoc. Proc. 43: 194-207.

(9) Harkom, J. F.
1932. EXPERIMENTAL TREATMENT OF HARDWOOD TIES. Amer. Wood Preservers Assoc. Proc. 28: 269-280.

(10) .....
1934. CREOSOTE TREATMENT OF GREEN BEECH, BIRCH, AND MAPLE TIES. Amer. Wood Preservers Assoc. Proc. 30: 346-355.

(11) Huffman, J. B.
1958. KILN DRYING OF SOUTHERN HARDWOOD CROSSTIES. Forest Prod. Jour. 8: 165-171.

(12) Humphrey, C. J., and C. Audrey Richards.
1939. RAILROAD TIE DECAY. Amer. Wood Preservers Assoc. 55 pp., illus. Washington, D.C.

(13) Krieg, W.
1953. PATENT COVERING SPECIALIZED PRESSURE TREATMENT OF EUROPEAN BEECH. German Patent No. 898,803.

(14) Krzyzewski, J.
1956. DURABILITY DATA ON TREATED AND UNTREATED TIMBERS. Canada Dept. North. Affairs and Nat. Resources, Forestry Branch, Forest Prod. Lab. Div. mimeo 0-105-55, 59 pp.

(15) Milovanovic, A.
1953. AN ATTEMPT AT IMPREGNATING STANDING TREES. Glasn. Sum. Fak., Beograd. 6: 67-73.

(16) Rand, E. Roger.
1953. THE VALUE OF INCISING HARDWOOD CROSSTIES. Amer. Wood Preservers Assoc. Proc. 49: 240-244.

(17) Redding, L. W.
1958. THE RESISTANCE OF VARIOUS TIMBERS TO IMPREGNATION. Dept. Sci. and Indust. Res., Forest Prod. Res. Lab., 49 pp., illus. Princes Risborough, England.

(18) Rutgerswerke, A. G.
1954. PATENT COVERING SPECIALIZED PRESSURE TREATMENT OF EUROPEAN BEECH. French Patent No. 1,064,227.

(19) Schulz, G.
1961. TREATMENT OF SLEEPERS AND TIMBERS OF GERMAN RAILWAYS. Brit. Wood Preserving Assoc. Ann. Conv. Rec. 1961: 29-58.

(20) Teesdale, C. H., and J. D. MacLean.
1918 RELATIVE RESISTANCE OF VARIOUS HARDWOODS TO INJECTION WITH CREOSOTE. U.S. Dept. Agr. Bul. 606. 36 pp., illus.

(21) United States Forest Products Laboratory.
1958. FACTORS THAT INFLUENCE THE DECAY OF UNTREATED WOOD IN SERVICE AND COMPARATIVE DECAY RESISTANCE OF DIFFERENT SPECIES. U.S. Forest Prod. Lab. Rpt. 68, 6 pp.

(22) Wolman, Karl.
1942. PATENT COVERING TREATMENT OF BEECH BY APPLYING WATER-BORNE PRESERVATIVES TO LOG ENDS. (U.S. Patent No. 2,297,273). U.S. Pat. Off., Off. Gaz. 542: 937.

(23) Wyman, Edgar P.
1956. BEECH FOR CROSSTIES. Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 15. 13 pp., illus.

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